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AIRCRAFT RESEARCH AND DEVELOPMENT UNIT

(9) ENGINEERING REPORT

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(6) FITMENT OF 'TAMAM' STANDBY ATTITUDE INDICATORS
TO MACCHI AIRCRAFT.

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Aircraft Research and Development Unit (ARDU), reworked Macchi MB 326H Draft Modification Order No 365 to install the 'TAMAM' Standby Attitude Indicator (SAI) in the front and rear instrument panels of Macchi aircraft. Modifications were also developed to provide independent switching and circuit protection for each SAI on the existing FIRE/OVERHEAT panel in the Right hand console of the front cockpit. RPM Indicator lighting control was transferred from its individual rheostat to the panel lighting control and protection circuit.

The modification was successfully test flown with particular emphasis on instrument readability, lack of conflict with the flight controls and ease of operation.

Residual errors noted in the SAIs after manoeuvres were large but were immediately cancelled by operation of the caging knob.

Trial flying of the installation showed the modification to be operationally acceptable and fleet wide installation was recommended.

AIRCRAFT RESEARCH AND DEVELOPMENT UNIT

FITMENT OF 'TAMAM' STANDBY ATTITUDE INDICATORS
TO MACCHI AIRCRAFT

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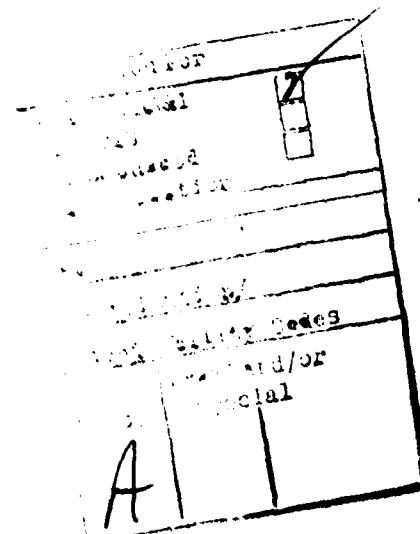
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AIRCRAFT RESEARCH AND DEVELOPMENT UNIT

TECHNICAL INVESTIGATION NO 683

FITMENT OF 'TAMAM' STANDBY ATTITUDE INDICATORS TO MACCHI AIRCRAFT

SUMMARY

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REPORT NO TI 683

FITMENT OF 'TAMAM' STANDBY ATTITUDE INDICATORS IN MACCHI
MB-326H AIRCRAFT FRONT AND REAR COCKPITS

- References:
- A. Technical Investigation (TI) No 683
 - B. Macchi Modification No 365 (Draft)
 - C. Report No TI 567
 - D. ARDU 2535/2/683/TECH.13) of 11 August 1980

INTRODUCTION

1. Aircraft Research and Development Unit (ARDU) was tasked under Reference A to develop a Draft Modification Order (DMO), to install TAMAM standby attitude indicators in both the front and rear cockpits of Macchi MB-326H aircraft. To accomplish this task, a trial fitment and static and flight evaluation of the installation in both cockpits was to be carried out. This assessment was to be based on the following critical areas already highlighted by RAAF Base East Sale after trial incorporation of Commonwealth Aircraft Corporation's (CAC) draft Macchi Modification NO 365:

- a. clearance between the caging knob and control column;
 - b. instrument readability; and
 - c. ease of instrument installation and removal.
2. This report details the development of the modification and discusses the engineering decisions taken to overcome the installation problems encountered. It also records the results of the flight trials conducted and makes suggestions for further improvement to the installation to make it completely operationally acceptable.

CONDITIONS RELEVANT TO THE MODIFICATION DEVELOPMENT

Aircraft

3. Macchi aircraft A7-080 was selected for the prototype installation. That aircraft had both Macchi modifications Nos 349 and 54 incorporated, so related cockpit configuration changes were minimised for the development of the TAMAM installation requirements.

4. An initial measurement of the upper instrument panel mounting angle in both cockpits of the aircraft revealed the front panel to be slung at 10° to the vertical and the rear at four degrees reverse tilt. Comparison with other aircraft at ARDU showed varying mounting angles on all Macchi panels. As a result, it was decided to shim the panels to a designated tilt as a prerequisite to installing the standby attitude indicators (SAI). Angles chosen were seven degrees and three degrees for the front and rear upper

panels respectively. In order to standardise the panel mounting procedure, the aircraft was jacked and levelled laterally and longitudinally, and a clinometer utilized during the installation of appropriate shims to produce the requisite tilt. Setting the front panel to seven degrees facilitated direct installation of the IAMAM SAI in that panel, and a machined four degree wedge enabled installation of the rear SAI at seven degrees as required.

DEVELOPMENT OF THE PROTOTYPE INSTALLATION

Instrument panels

5. The SAI was installed in the front instrument panel in place of the auxiliary UHF control box which was relocated adjacent to, and outboard of the Fire/Overheat test switches on the right console. The auxiliary UHF box location was reworked to accept the SAI mounting hardware.

6. The rear cockpit SAI was installed in the upper instrument panel in the space previously occupied by the clock (or RPM gauge subsequent to Macchi Modification No 349). These instruments were mounted on a bracket adjacent to, and outboard of, the fuel flow gauge.

Fire/Overheat Panel

7. The Fire/Overheat Panel in the front cockpit was removed, stripped and discarded. A redesigned panel was constructed and installed in the same location. On that new panel, only the switches transferred from the previous panel and the control switching for the SAIs were installed. The RPM Indicator post lighting rheostat was removed entirely and the lighting incorporated in the panel lighting control circuit.

8. In order to retain the emergency nature of the SAI installation, separate switching and individual one ampere circuit breakers were installed on the panel. This control configuration allowed separate and individual control of both the front and rear SAIs from the front cockpit. In the event of failure of either SAI the other instrument would still be available for attitude reference (provided that cockpit was occupied).

Support for SAIs

9. A mounting bracket was designed and constructed by reworking a similar item from the Macchi Modification No 365 mod kit. This bracket was required to support the body of each SAI and to carry the panel electrical loom plugs to enable individual panel removal without disconnection of the looms from the junction blocks.

DRAFT MODIFICATION ORDER ENGINEERING CHANGES

10. The installation procedure outlined in Macchi Modification No 365 was so extensively changed during the ARDU trial installation, that a completely revised DMU was prepared and despatched separately to HQSC Engineering Staff under cover of Reference D. The more significant changes from the original were as follows:

- a. Two switches and circuit breakers were installed to separately control and protect the individual SAIs instead of the single circuit breaker recommended in Modification No 365.
- b. The RPM Indicator lighting rheostat was removed and the Indicator lighting incorporated in the controllable panel lighting circuit.
- c. Macchi Modification No 54 was partially superseded by the incorporation of the trial modification.
- d. A Watts Clinometer was used by ARDU to establish the seven and four degree panel mounting necessitated by the seven degree SAI tilt requirement. A panel adapter plate was used to mount the clinometer. This was again fabricated by ARDU but incorporating units may have alternative installation hardware at their disposal to set the panels.
- e. Item 3 in the modification parts list was deleted from the original Modification 365 list and a new panel designed and constructed.
- f. Item 5 in the list was changed from one 2 ampere circuit breaker to two 1 ampere breakers.
- g. Item 8, the wedge, was discarded and a new mounting wedge designed and constructed.
- h. New items 15 and 16, Bracket and Switches respectively, were included.
- i. Original item 15, nameplate, was discarded and a new decal designed and printed to indicate the functions on the reworked Fire/Overheat Panel.
- j. Items 15 to 35 were renumbered to items 16 to 38. Item 38 called for panel adjusting shims as required to set the two panels to the required angles.
- k. The method and sequence of incorporation were changed to reflect the revised installation procedure.

GROUND EVALUATION

Clearance Between Caging Knob and Control Columns

ii. With the control columns in either cockpit set to the normal rigged positions and the front and rear SAIs installed in the instrument panels in accordance with the revised DMO, clearance checks were carried out. These comprised:

- a. A straight edge check along the alignment of the individual control knobs already in the panel and the newly installed SAI caging knob in the 'CAGED' position; and
- b. Manipulation of the two control columns throughout their full travel at all settings of the ejection seats.

12. In both cockpits, a gloved hand gripping the column cleared the caging knob in the 'caged' position by ten millimetres. With slight knuckle extension, the fingers impinged upon the HSI setting knob prior to contacting the caging knob. As this was normally accepted operationally, no further recessing was required for the SAI.

Instrument Readability

13. Both SAIs were readable in all positions of the ejection seat. However, the OFF flags were only barely visible due to both the recessed mounting of the indicators and slight parallax. This aspect was also commented upon during the flight evaluation.

Ease of Instrument Installation and Removal

14. Panel mounting of both SAIs, with rear wedging in the rear cockpit, produced no adverse installation or removal conditions. Mounting of the electrical connectors at the rear of the instruments was such that the instruments could be withdrawn from their mounting holes, disconnected and then removed entirely.

Comparison Between IAMAM SAI and Main Attitude Indicator

15. Apart from the obvious physical size differences between the TAMAM SAI and the normal Attitude Indicator (AI), the most significant difference between the two was reversal of the sky pointers. On the TAMAM instrument, the pointer was orientated towards the ground whereas, on the main indicator, the pointer indicated the sky sector. This was considered a possible source of confusion in an emergency situation.

Run-up Time

16. The gyro systems in the SAI took two minutes from 'switch on' to settle down and establish correct attitude indication. When switched on and caged, the indicator showed the correct attitude immediately upon completion of run-up and uncaging. However, when started uncaged, the instrument required caging upon completion of the run-up time before it indicated correctly. This situation was considered normal and was not assessed as posing a problem in operation.

FLIGHT TRIALS AND PILOT EVALUATION

Start 'Caged - Front Cockpit

17. During the initial pilot evaluation and preparation for inflight testing, the aircraft was started with the front cockpit SAI switched 'ON' and caged. The start sequence took two minutes. Upon completion of the sequence, the instrument was 'uncaged' and indicated correct attitude and sense. This followed an acceptable procedure and was considered the preferable starting method to be adopted.

Start 'Uncaged -Rear Cockpit

18. With the rear cockpit SAI uncaged and selected 'ON', the aircraft was again started. After the gyro started to run up, the instrument gimballed for 40 seconds then stiffened to indicate 20° nose up. Upon completion of

the two minute start sequence the SAI had settled to wings level, 10° nose up. A further two minutes later, it had settled to 5° nose up. It was then manually setted by operation of the caging knob which immediately corrected the 5° error. It then indicated correctly until the completion of the sortie.

Flight Trials

19. After takeoff, the SAIs indicated normally and sympathetically with the main AI in normal flight. Following aerobatic manoeuvres, comprising a left spin, left stall turn and right stall turn, the accumulated attitude errors indicated were eighteen degrees nose high and ten degrees right bank. These errors were the sum of the residual errors observed at the completion of each manoeuvre.

20. Upon recovery from the left spin both SAIs indicated six degrees nose down and twenty degrees left bank.

21. A stall turn to the left was then initiated and, upon completion, revealed a residual error of 15° nose down and 15° left bank.

22. Upon completion of the final stall turn to the right, the SAIs showed 18° nose up and 10° right bank. With operation of the caging knobs, both SAIs erected immediately and continued to indicate correctly for the remainder of the flight.

23. The project pilot reported he could apply up to two degrees of bank in either direction without detecting any visual indication on the SAI. This was considered to be due to parallax error but was not operationally significant. Similarly, it was not as easy to detect small pitch changes in the SAIs compared with the main instrument but, taking cognizance of the emergency nature of the SAIs, this deficiency was considered operationally acceptable.

24. The project pilot did, however, report difficulty in differentiating between the switches and circuit breakers visually on the Fire/Overheat Panel due to their being partially obscured by the stowed utility light. Tactile sensing would appear more appropriate pending repositioning of the light.

25. Similarly, the recessed, off centre mounting of the SAIs caused only 1.5 mm of the 'OFF' flags to be visible. This fault necessitated concentration on the instrument and would be advantageously resolved if the OFF flag was enlarged or relocated to the upper right quadrant of the instrument.

26. A night evaluation sortie was carried out to compare the lighting arrangements for the SAIs and ensure their reliability with reduced visual references. Whilst both SAIs performed their attitude indication role satisfactorily, their integral lighting was about twice as bright as necessary when the remainder of the panel was set to a comfortable level, and the colour was white while the rest of the panel was red. These situations necessitated rework of the integral lighting in the SAIs and were considered outside the scope of the TI. They should however, be taken into account during the cockpit lighting rework.

27. Activation of the lighting is taken from the five volt AC instrument lighting circuitry. ARDU considers it would be better to operate the SAI lighting from the essential DC bus, as the instruments were installed as an emergency backup should the aircraft's AC supplies fail.

28. As these lighting anomalies will be addressed in conjunction with the current Macchi cockpit lighting rework and evaluation, they were not altered during the trial installation.

CONCLUSIONS

29. ARDU installed the TAMAM Standby Attitude Indicators in the front and rear cockpits of Macchi aircraft A7-080 with several changes to the CAC proposed Macchi Modification No 365 format and hardware. No significant problems were encountered in the installations in either cockpit and ground and flight trials proved the operational acceptability of the modification.

30. The modification is within operating unit capabilities to install and should present no engineering difficulties for manufacture.

31. Minor cockpit layout changes were incorporated with the modification installation. These do not significantly affect the normal operation of the aircraft.

RECOMMENDATIONS

32. As a result of the flight evaluation of the installed SAIs, ARDU recommends:

- a. Fleet-wide incorporation of the TAMAM Standby Attitude Indicators in Macchi aircraft at unit level,
- b. Changing of the SAI internal lighting from white to red;
- c. Powering of the internal lighting of the SAIs from the essential DC bus bar instead of the five volt AC normal instrument lighting circuit,
- d. Repositioning of the utility light to make the Fire/Overheat Panel switches and circuit breakers more visible; and
- e. Modification of the OFF flags in the SAIs to make them more readily visible in the recessed, off centreline installation.

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AIRCRAFT RESEARCH AND DEVELOPMENT UNIT

TECHNICAL INVESTIGATION NO 683

FITMENT OF 'TAMAM' STANDBY ATTITUDE INDICTORS
TO MACCHI AIRCRAFT

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